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IONOSPHERIC DISTURBANCES IN MIDDLE LATITUDES. THESES.

Ionospheric disturbances are little known as yet. The vast material of observations during AGI will give large possibilities for the investigation of this difficult question. It is therefore desirable to discuss some main questions of the method of investigations of ionospheric disturbances, particularly the question of criterion of disturbances, the method of distiguishing ionospheric disturbances according to the ionospheric data, the classification of the disturbances according to types, the main characteristics of disturbances, which are desirable to be informed of in catalogues, the kind of catalogue etc.

Up to the present time the investigations of ionospheric disturbances are made considering the state of the ionosphere during magnetic storms. In this work the regularities of ionospheric disturbances, distinguished directly from ionospheric data, were investigated.

The ionospheric disturbances during the years near maximum (1948 u 1949) and minimum (1952 u 1953) of solar activity were considered according to data of five stations in the belt 40°-60°N.

2. As the primary criterion of ionospheric disturbances we take

$$\Delta\ foF2\ \% = \frac{foF2(Mc) - foF2_{norm}(Mc)}{foF2_{norm}(Mc)} \cdot 100,$$ where foF2 is the critical frequency for the given hour, $foF2_{norm}$ is the critical frequency taken on running median calculated as 30 days for the same hour.

3. Ionospheric disturbances in middle latitudes, independently from the period of the solar activity, are either negative (D_-), or positive (D_+), seldom bifasic (D_{+-}), and very seldom mixed (D_{mix}). May be the two last types are just casual combination of the first two general types.

The distrubuion of the disturbances of different types in the belt 40°-60° N is shown in table 1.

Table 1

(100% is the number of the storms of all types)

Type of the storms	Big and moderate storms		Little storms	
	sp-max	sp- min	sp-max	sp -min.
D_-	61%	50%	45%	29%
D_+	18	33	45	56
D_{+-}	17	12	5	9
D_{mir}	4	5	5	6

sp- max = years of maximum the sunspot numbers,

sp- min years of minimum the sunspot numbers.

4. The catalogue of ionospheric distrubances for 4 years on 4 stations was compiled. The following information are given in the catalogue: the date and the time of the beginning and the ending of the disturbance; the type of the disturbance; its duration in hours; maximum of Δ_{dist} foF2 in per cent with the indication of the sign (+ or -); ~~medium~~ main value of Δ_{dist} foF2 for the whole period of the disturbance; the time of the beginning and the end of active periods of the given disturbance; A- characteristic of the disturbance; the category of the disturbance (very big, big, moderate, little).

5. The "Forbidden" time for the beginning of ionospheric disturbances of any type is revealed. The probability that big and moderate ionospheric disturbances cannot begin in the period of the "forbidden" time is very great, it is aboout 100%.

Diagrams of the duration of "forbidden" periods depending on season and geographycal latitude for the belt 40°-60°N are compiled (Fig.1).

6. For practical aims it is very important to know the daily variation of Δ_{dist} foF2 and also the daily variation of the

A - characteristic, i.e. the probability that during the storm of a certain type, the given hour of the day will be active.

Each value of $\triangle_{dist}$ foF2 will be equal to the sum of two values

$$\triangle_{dist} foF2 = D_{st} (\triangle_{dist} foF2) + S_D (\triangle_{dist} foF2)$$

The diagrams of the daily variation of $\triangle_{dist}$ foF2 with season and solar activity are compiled for the different type of storms in the belt 40°-60° N (Fig.2).

The practical conclusions on the daily variation of the intensity of the storms and of the probability of their active hours are given in the tables 2 and 3.

Table 2

The most conveniet working hours of radio communication during type D_- disturbances in the belt 40°- 60°N

Years	Season	Local time in the region of the reflection of wave (the most convenient hours)	Probability that these periods of disturbances will not be active (%)	Mean deviation of foF2 in these periods from the normal values (%)	Mean deviation of foF2 if these periods will still be active (%)
sp-max	Winter	from 8 till 16	80	- 10	-40
	Equinox	13 20	60	-15 -20	-30
	Summer	15 21	40	-20	-25
sp-min	Winter	8 16	80	-10	-25
	Equinox	13 20	60	-12-15	-25
	Summer	12 21	75	-12	-22

Table 3

The most difficult hours for the radio . communication during type D_ disturbances in the belt 40°-60°N.

Years	Season	Local time in the region of the reflection of waves (the most difficult hours)		Probability that these periods will be active	Mean deviation foF2 during the active periods of disturbances (%)
	Winter	from 20 till	6	0.6	-30
sp-max	Equinox	23	11	0.7	-25 - 32
	Summer	22	13	0.85	-30
	Winter	20	6	0.6	-25
sp-min	Equinox	23	11	0.6	-25 -27
	Summer	22	04	0.65	-25 - 30

7. Dst - vatiation is determined to find out the variation of intensity of ionospheric storm with the time from its beginning.

For practical purposes it is necessary to make clear at what day or hour of the disturbance we must wait for its largest intensity. The period of each storm was taken for a unit. Figures 3 and 4 show that practicticaly there is no regular change of intensity of disturbances with the storm-time i.e. Dst ≃ Dm.

Ionospheric storms practicaly begin in the middle latitudes at once, without slow and gradual decrease or increase of critical frequencies.

Therefore when predicting foF2 for the disturbed time it is quite sufficient to take into consideration only the daily variation $\triangle_{dist}$ .FoF2 and it is not necessary to consider the changes of $\triangle_{dist}$ with the storm-time, because the indivi-

dual ionospheric disturbances may have the largest intensity at any part of its period.

8. The obtained conclusions essentially differ from those in literature. This is explained by the fact that before the beginning of statistical calculation of mean characteristics, the storms, at first, were divided and grouped in accordance with definite types, secondly, while calculating of $\triangle_{dist}$ seasonal variation were taken into account, and at past, the ionospheric storms were distinguished not by magnetic data but directly by ionospheric data.

The comparison of the obtained results with real variations of the critical frequences of F2-layer during the disturbances confirms the obtained results.

9. Proposals for the discussion

1) In studying mean characteristics of ionospheric disturbance is recomended:

(a) To distinguish periods of disturbances by ionospheric data, without automatic equalization of ionospheric disturbances with magnetic ones.

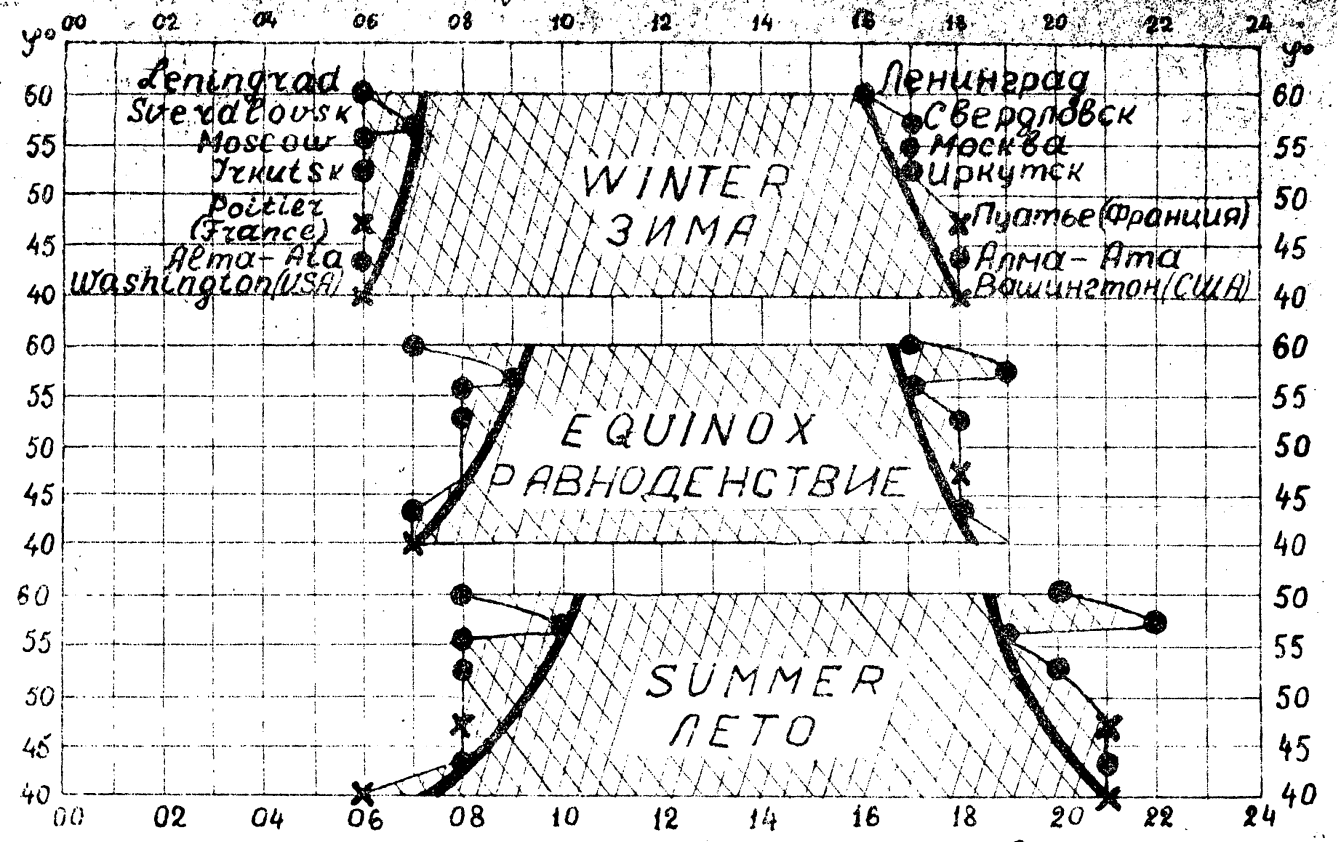
(b) To divide and group the ionospheric disturbances in types before the beginning of statistical calculations, not admitting the calculation of mean characteristics by common mean value of negative and positive storms.

(c) The deviations foF2 in relative units, or per cent, from the running median may serve as quantitative criterion of ionospheric disturbances in middle latitudes. The ussage of the running median is necessary to account the seasonal variation foF2.

(d) To include the following data during the compilement of the catalogue of ionospheric storms:

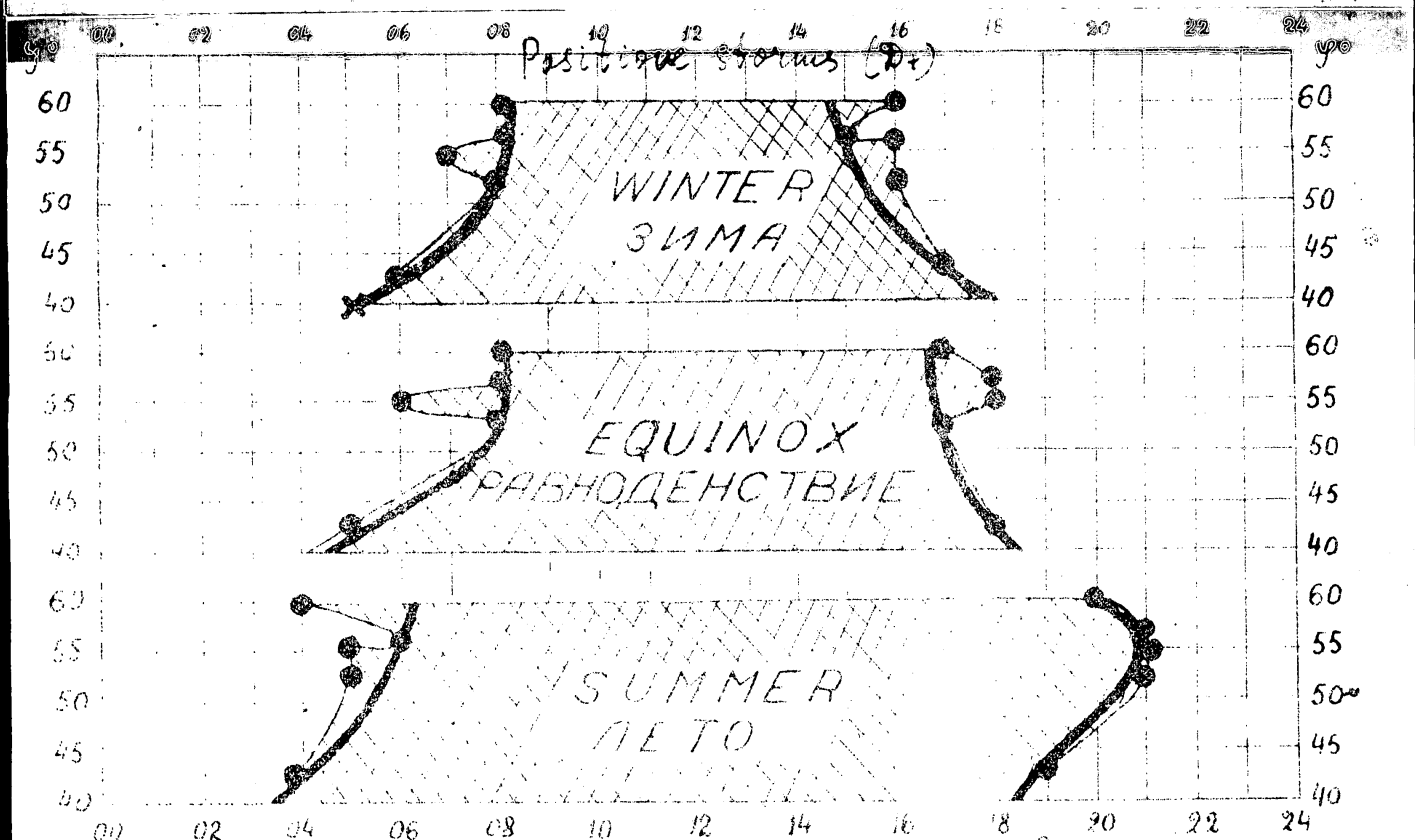
date and time of the beginning and ending of disturbance, its duration in hours, maximum $\triangle_{dist}$ foF2, mean value of $\triangle_{dist}$ foF2 during the storm, the time of the commencement and the ending of active periods, A -characteristic, the category of the disturbance (vb, b, m, l)

(2) It is recomended for practical purposes to use the graphs of "forbidden" time for the beginning of storms (Fig 1) and the table 2 and 3 about the most convenient and the most difficult working hours during storms. Particularly they may be used for the short-time predicting of ionospheric conditions in middle latitudes.



local time поясное время

„Forbidden" time for the beginning of storms (is crossed)

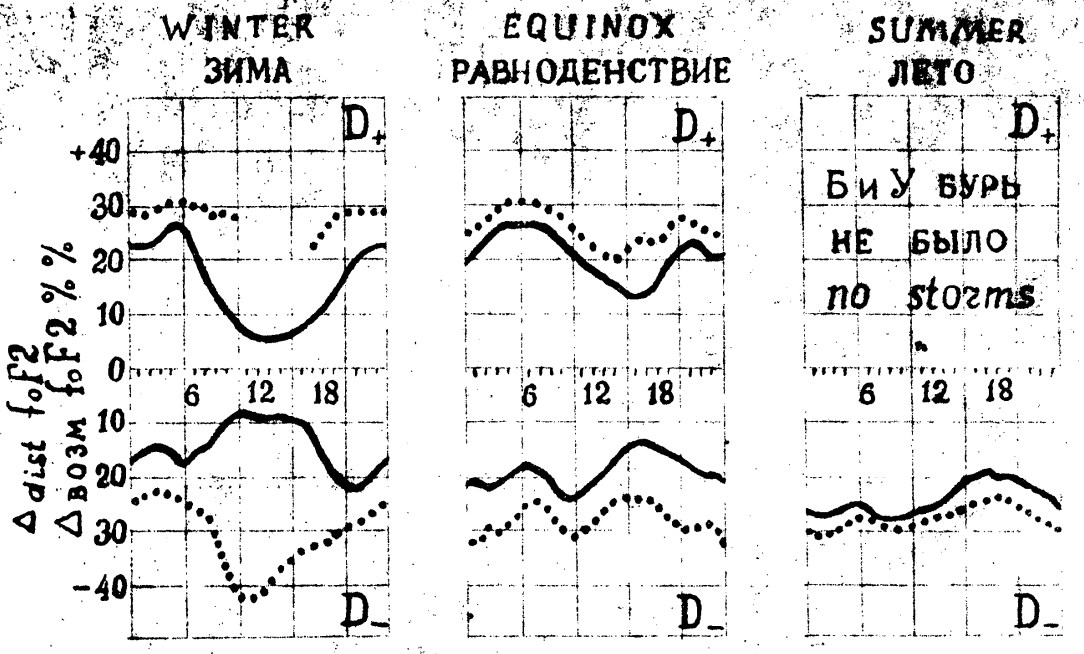


local time поясное время

Рис 1

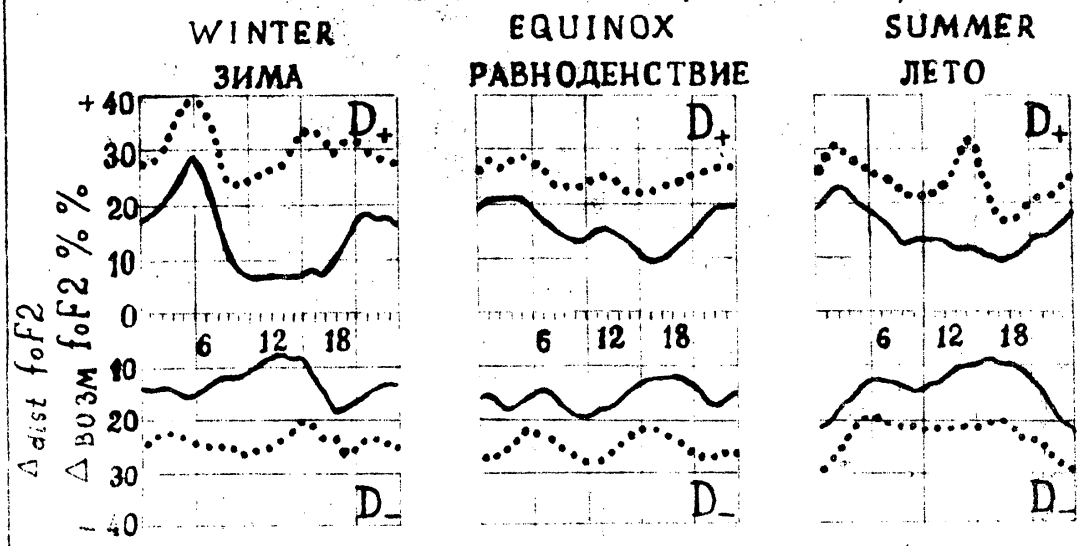
SP - MAX

ГОДЫ СП-МАКС (1948 и 1949 гг)



SP - MIN

ГОДЫ СП-МИН (1952 и 1953 гг)



LOCAL TIME — ВРЕМЯ МЕСТНОЕ ПОЯСНОЕ

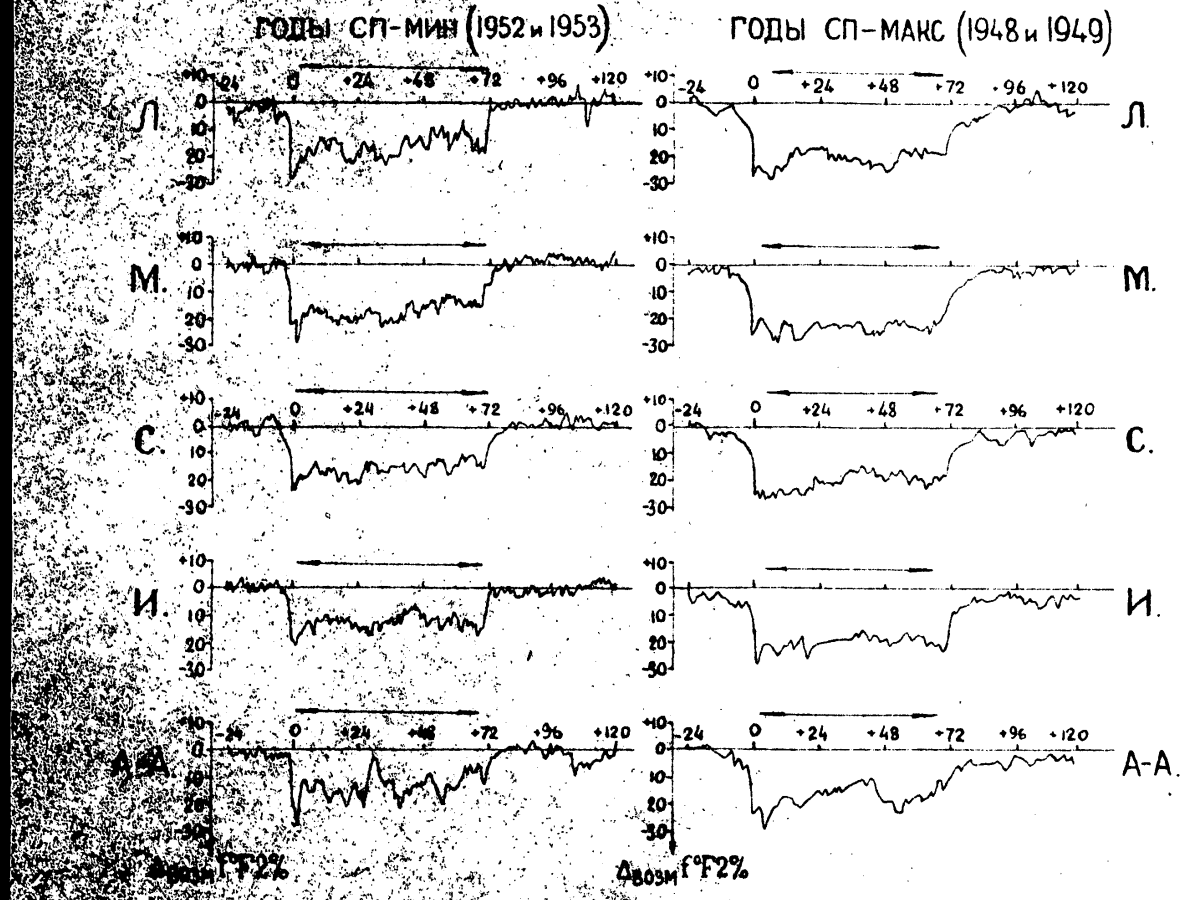
——— all hours of storm — ——— ПО ВСЕМ ЧАСАМ БУРИ

····· only active hours of storm — ····· ПО АКТИВНЫМ ЧАСАМ БУРИ

Рис. 2 Diurnal variation of the intensity of the and the corresponding

negative disturbances

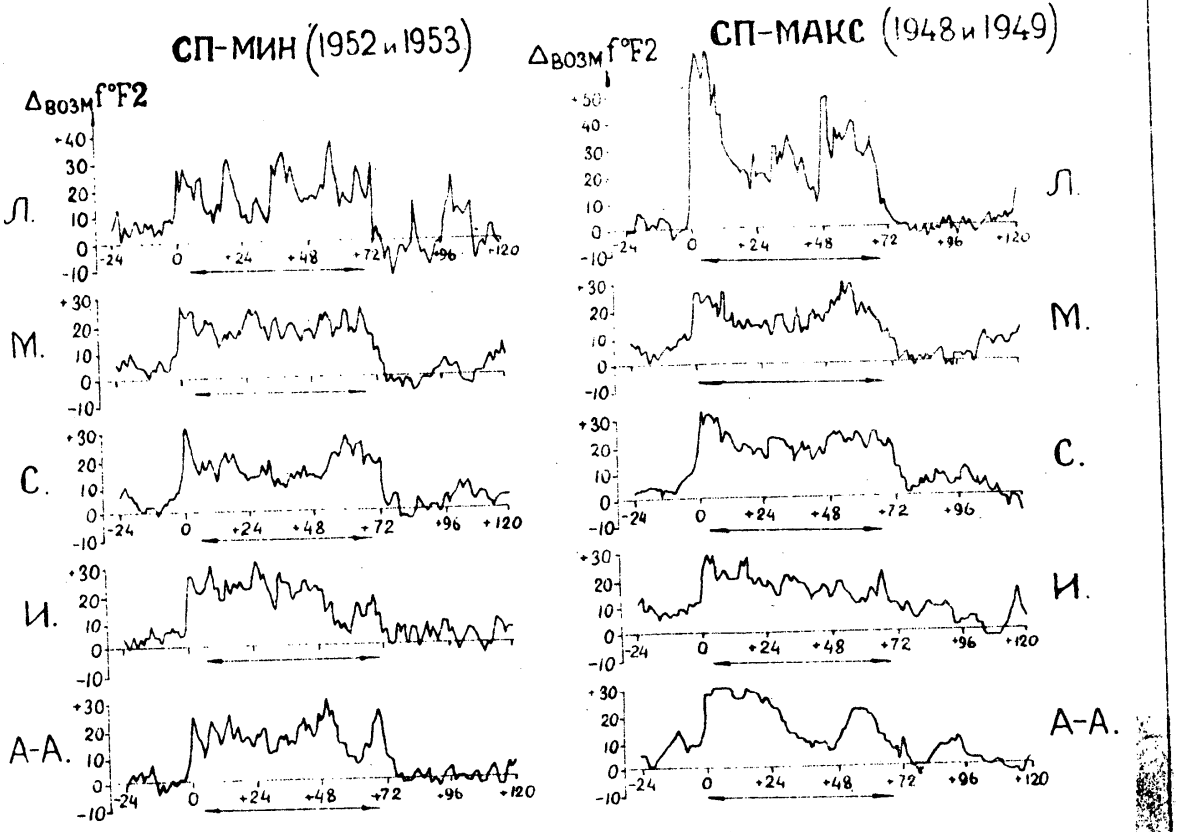
ОТРИЦАТЕЛЬНЫЕ ВОЗМУЩЕНИЯ



D_{st} (Δ_{dist} foF2) - variations

positive disturbances

ПОЛОЖИТЕЛЬНЫЕ ВОЗМУЩЕНИЯ



D_{st} (Δ_{dist} f_oF2) - variations